JPRS-UMS-84-007

24 October 1984

USSR Report

MATERIALS SCIENCE AND METALLURGY

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

CONTENTS

ALUMINUM AND ITS ALLOYS

UDC: 539.43:669.715:620.19

CRACK RESISTANCE OF PRESSED AND ROLLED SEMIFINISHED GOODS OF ALUMINUM ALLOYS USED IN LOAD-BEARING AIRCRAFT WING STRUCTURES

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20 No 2, Mar-Apr 84 (manuscript received 23 Sep 82) pp 99-102

VOVNYANKO, A. G. and DOTSENKO, A. M.

[Abstract] The purpose of this study was to determine the crack growth rate for long cracks typical of those which can be visually detected upon inspection of aircraft structures. The stress intensity factor representing the residual strength of thin-walled structures with long cracks was also determined. Determination of the optimal quantities of alloying elements in the alloys 1163 and 1161 and increases in the purity of these alloys in terms of iron and silicon have decreased crack growth rates. Stress intensity factor increases with increasing width of the specimen, particularly at widths over 500 mm. The influence of relative crack length on the change in stress intensity factor is practically independent of width. Pressed panels of D16chT are superior to rolled plates of the same alloy in cylindrical crack resistance and critical stress intensity factor. Figures 4; references 6: all Russian.
[108-6508]

UDC 539.213.2:539.37

PARAMETERS OF STRUCTURAL RELAXATION AND MECHANICAL PROPERTIES OF AMORPHOUS ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 57, No 6, Jun 84 (manuscript received 26 Aug 83) pp 1198-1210

GLEZER, A. M. and UTEVSKAYA, O. L., Institute of Precision Alloys; Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] The relation between mechanical properties of amorphous alloys $(Fe_{1-x}Ni_x)_{82.5}P_{17.5}$ $(0 - x - 0.4)$, $Fe_{40}Ni_{40}P_{16}B$, $Fe_{82.5}B_{17.5}$, and also $(Fe_{100-y}Me_y)_{82.5}B_{17.5}$ (Me = Ce,Sb,Nb; y = 0.01, 0.1, 1.0) and their structural relaxation during annealing has been established in an experimental study involving microhardness, electrical resistivity, and plastic deformation measurements as well as dilatometry with an ULVAC-TA-1500 apparatus at a heating rate of 2°C/min, fractography after uniaxial tension tests under a scanning electron microscope with x5000-60,000 magnification and low-angle high-resolution diffractometry with Co-K_α radiation. Specimens of all alloys in the form of 20-50 μm-thick and 1-22-mm-wide ribbons were produced by quenching from the melt by the spinning method. They were heat treated in a vacuum furnace at temperatures ranging from 50 to 450°C for periods of time ranging from 6 min to 10 h. An evaluation of the data with the aid of regression analysis, and using the concept of vacant spaces as a form of defects, has yielded the dependence of the Vickers hardness and the yield point of Fe-Ni-P and Fe-Ni-P-B alloys on the parameters of their preparation process and subsequent heat treatment, and also of the electrical resistivity of Fe-Ni-P and Fe-P alloys on the heat treatment parameters. On this basis are now analyzed the processes of cold hardening and the effect of microalloying with surfactant elements on structural relaxation. The latter appears to proceed in three usually sequential and sometimes simultaneous stages as the annealing temperature is raised: 1) segregation on vacant spaces with active participation of non-metallic atoms; 2) relaxation of vacant spaces accompanied by compaction of the amorphous matrix; 3) formation of distinct topological short-range configuration preceding precipitation of crystalline phases. The authors thank L. S. Palatnik and P. G. Cheremskiy for facilitating low-angle x-ray diffractometry of the amorphous alloys, Yu. L. Rodionov and T. I. Mushakova for assisting in dilatometry and electrical resistance measurements. Figures 9; references 23: 9 Russian, 14 Western (1 in Russian translation). [154-2415]

UDC 669.15'25'782'781-192:539.213.2:538.27

EFFECT OF ANNEALING IN TRANSVERSE MAGNETIC FIELD ON MAGNETIC PERMEABILITY OF AMORPHOUS $Fe_5Co_{70}Si_{15}B_{10}$ ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 57, No 6, Jun 84 (manuscript received 28 Jun 83) pp 1213-1215

KEKALO, I. B., ZHDANOV, A. N. and TSVETKOV, V. Yu., Moscow Institute of Steel and Alloys

[Abstract] While annealing of crystalline and amorphous magnetically soft materials in a longitudinal magnetic field improves some of their magnetic properties but decreases their initial magnetic permeability, annealing them in a transverse magnetic field will under certain conditions increase it. This possibility is analyzed theoretically on the basis of the relation $\mu_a \sim \frac{I_s^2 S}{\partial^2\gamma/\partial x^2}\cos^2\varphi$ for amorphous materials (I_s-saturation magnetization, S-specific surface area of domains, γ-specific energy of domain walls, φ-angle between H-vector and I_s-vector in a domain) and the effect of annealing on the various quantities in this relation. It has been demonstrated experimentally on the $Fe_5Co_{70}S_{15}B_{10}$ alloy, which has the Curie point at 370°C and the crystallization point at 500°C according to differential thermographic analysis. Toroidal specimens of this alloy were produced by the method of quenching from the melt on a fast spinning disk. They were subjected to thermomagnetic treatment at 250°C (below the embrittlement point), in a longitudinal field of 800 A/m intensity and in a transverse magnetic field of $5.6 \cdot 10^5$ A/m intensity, then held at that temperature for 18 h. The effective magnetic permeability, initially 3000, decreased immediately to 550 during annealing in the longitudinal field and then increased to 6000 within the first 45 min of annealing in the transverse field, whereupon it slowly decreased back to 3000 during subsequent soaking at 250°C. Preannealing the alloy in the transverse field at 410°C (above the embrittlement point) and then cooling in water raised the initial effective magnetic permeability to 32,000. Subsequent treatment in the longitudinal field reduced it to 1300 and another treatment in the transverse field raised it again, but not above 12,000. It thus appears feasible to appreciably increase the initial magnetic permeability of an alloy without transition from nonmagnetostrictive to brittle state when the Curie point is lower than the crystallization point. When the Curie point is higher, it is possible to achieve this without resorting to laborious treatment in a rotating magnetic field. Figures 3; references 3: 2 Russian, 1 Western.
[154-2415]

UDC 669.15'24'25'782'781'/92:538/22

MAGNETIC PROPERTIES OF AND SUPERFINE INTERACTIONS IN AMORPHOUS Fe-Cr-Co-Si-B ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 57, No 6, Jun 84 (manuscript received 6 Jul 83) pp 1094-1100

DROZDOVA, M. A., ZHELNOV, A. N. and PROKOSHIN, A. F., Institute of Precision Alloys; Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] An experimental study of the amorphous $Fe_{80}B_{15}Si_5$ alloy was made for the purpose of determining the effect of adding chromium and cobalt simultaneously in equal amounts on its magnetic properties and crystallization temperature, such a determination being made easier by retention by an amorphous alloy of its single-phase structure over a wide range of added elements and their concentrations. Specimens of $Fe_{80-2x}Cr_xCo_xB_{15}Si_5$ ($0 \leq x \leq 14$) in the form of ribbon 20-40 μm thick and 1-20 mm wide were produced by spinning the melt. The crystallization point was determined by means of a differential scanning calorimeter during heating at a rate of 10°C/min. The magnetic properties were measured by two mutually complementing methods, Mössbauer spectroscopy for microproperties and saturation magnetization for macroproperties. The saturation magnetization was measured with a ballistic galvanometer in magnetic field of up to 60 kOe intensity at 4.2°K and 77°K, with a vibration magnetometer in magnetic fields of up to 10 kOe intensity during heating from 300 to 800°K at a rate of 7 degrees/min. An evaluation of the data on the basis of Heisenberg and Hubbard models yielded the x(cr,Co)-concentration dependence of the Curie point T_C and of the crystallization point T_X, of the isomeric shift after quenching and after annealing, of the mean superfine-magnetic-field intensity on an ^{57}Fe nucleus at 300°K, and of the mean magnetic moment per Cr or Co atom at 4.2°K and at 300°K, as well as the temperature dependence of the magnetization $M(T)/M(0) = f(T/T_C)$. The results indicate that the effect of chromium is predominant, both transition metals influencing the magnetic properties additively within the low $0 \leq x < 8$ range and nonlinearly with a strong effect of annealing within the high $x \geq 8$ range. Figures 5; references 11: 1 Russian, 10 Western (1 in Russian translation).
[154-2415]

UDC 539.219.3:539.213.2.001

SELF-DIFFUSION OF MONOVACANCIES IN SINGLE-COMPONENT AMORPHOUS METAL

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 57, No 6, Jun 84 (manuscript received 9 Aug 83) pp 1050-1056

BELASHCHENKO, D. K. and FAM KHAK KHUNG, Moscow Institute of Steel and Alloys

[Abstract] Self-diffusion of monovacancies in a disordered system containing various barriers with a discrete height distribution is analyzed, first for the case of a random distribution and then for the case of a deterministic one. Calculations are made on the basis of earlier derived expressions for the mean time between jumps from one node to another and for the correlation coefficient which characterizes the efficiency of vacancy capture by two-node traps. In the first case the diffusion correlation coefficient depends strongly on the form of the barrier height distribution, decreasing faster with decreasing temperature as the range of the distribution widens. This is attributable to a higher concentration of "blind" nodes with one low barrier and all other ones high, a situation in which diffusion is retarded. In the second case are considered two possible arrays of six barriers, one with all of different heights within the $(1.5\text{-}5.5)kT_0$ range and one with all of the same height $1.7kT_0$. Here, as the temperature decreases and the lowest barriers become increasingly predominant, the diffusion correlation coefficient decreases more nonlinearly and faster as the concentration of nodes with unequal barriers increases.
Figures 3; references 3: all Russian.
[154-2415]

UDC 621.785.5:669.1:669.295.5

IRON COATINGS ON VT3-1 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 84 pp 51-53

IVANOV, A. S., SOKOLOV, A. N. and TOMSINSKIY, V. S., Perm' Polytechnical Institute

[Abstract] Specimens of VT3-1 alloy were subjected to galvanic iron coating, producing a coating 20 to 100 μm thick. The specimens were then diffusion annealed in argon at 450 to 930°C to provide closer bonding of the iron and matrix. Annealing at below 650°C does not produce a diffusion zone between the phases. Increasing the annealing temperature leads to an increase in the width of the interlayer between the iron layer and the matrix. Layer-by-layer phase analysis showed that during high temperature annealing a number of diffusion zones of variable phase composition are formed, providing tight bonding between the iron coating and titanium base. When the material is heated to a temperature abo e the $(\alpha+\beta)\rightarrow\beta$ transition, a β-converting structure is formed which should prevent propagation of surface cracks into the depth of the part.
[118-6508]

UDC 669.295.5'786

HYDROGEN PERMEABILITY OF TiN COATING ON STAINLESS STEEL AND EFFECT OF BOMBARDMENT BY HELIUM IONS ON STRUCTURE AND CHEMICAL COMPOSITION OF SUCH COATING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 3, May-Jun 84 (manuscript received 22 Jul 81) pp 45-49

VINOGRADOVA, N. K., GUSEVA, M. I., IVANOV, V. M., MANSUROVA, A. N., MOROZOV, V. N. and STEPANCHIKOV, V. A., Moscow

[Abstract] Coating of stainless steels with TiN (melting point 3223°K, energy of atomic bond 305 kcal/mole, embrittlement temperature above 1000°C) is considered for protecting the blanket of a fusion reactor against its interaction with the coolant, the moderator, and the breeder material, another

advantage being that it has almost the same coefficient of thermal expansion ($9.8 \cdot 10^{-6}$ at 20°C). With reference to this application, an experimental study was made for the purpose of determining the hydrogen and tritium permeability of this coating material as well as the effect of bombardment by helium ions on its structure and chemical composition. Coatings were deposited at a rate of 3-5 μm/min on 0.1-mm-thick foil specimens of OKh18N10T steel at a temperature of 150-200°C by vacuum evaporation and condensation, under a pressure of 1300 Pa with an arc-discharge current of 70-80 A at 35-40 V. The specimens were placed in an ILU-3 ion accelerator under a scanning beam of 100 keV He^+ ions and bombarded with a dose of $2 \cdot 10^{19}$ ions/cm^2 at three temperatures (20, 200, 400°C). The coatings had retained their original characteristic golden color. Subsequent microstructural examination and Auger-electron spectral analysis, upon comparison with the steel surface without coating, have revealed that TiN coating inhibits blistering of stainless steel but does not the tritium permeability. The latter is diminished by calorization, heat-resistant enameling, or vacuum metallization. The hydrogen permeability remains high after coating with TiN, any diminution being contributed mainly by the ε-Ti_2N layer rather than by both TiN and α-Ti phases. The spectrometer used in this study had an energy resolving power of $\Delta E/E \geq 0.6\%$ so that it was not possible to sharply separate the nitrogen and titanium peaks of 386 and 381 eV, respectively. The authors thank V. M. Yampol'skiy for guiding the construction of arc-discharge equipment with hollow cathode for vacuum deposition of coatings.
Figures 3; references 5: 3 Russian, 2 Western.
[125-2415]

CHEMICAL NICKEL PLATING METHOD FOR POLYAMIDE PARTS

Moscow LENINSKOYE ZNAMYA in Russian 1 Aug 84, p 3

[Text] Moscow engineers have perfected a process for applying chemical nickel to polyamide parts with complex shapes. A surface with such a coating solders well, conducts electricity and can be used for electric shielding.

Unlike existing methods for chemical nickel plating, this method uses a low-temperature solution with a working temperature of 30-40 degrees Celsius. The proposed process makes it possible to isolate places on a part which do not have to be plated. Another merit of such chemical nickel plating is that it saves costly titanium and makes parts less laborious to manufacture.

FTD/SNAP
CSO: 1842/132

UDC 535.211:539.219.2

BREAKDOWN OF POROUS METALS BY LASER RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 3, May-Jun 84 (manuscript received 10 Nov 83) pp 21-24

UGLOV, A. A. and GREBENNIKOV, V. A., Moscow

[Abstract] Breakdown of a powder metal by laser radiation is analyzed, considering first the fundamental characteristics of melting as a quasi-steady process under a constant localized energy flux. Calculations for the typical 10^5-10^7 W/cm^2 range of laser radiation density reveal that the trends of the porosity dependence of both the melting depth and the critical radiation flux density for initiation of boiling is determined by two thermophysical properties of the metal powder, namely its latent heat of evaporation and thermal conductivity, as well as by the laser-pulse duration. The melting depth is maximum within the 24-32% range of porosity, the peak becoming sharper and shifting toward lower porosity as the incident radiation flux density increases. Theoretical estimates of the critical radiation flux density are higher than its experimental values obtained for molybdenum and nickel, and the discrepancy increases with increasing porosity. Pore kinetics and formation of a crater under high-intensity laser radiation are considered subsequently, with the free surface energy taken into account, calculations revealing the role of pores as heat boosters. An approximate relation for the crater depth is derived for process design purposes. Figures 2; references 8: all Russian.
[125-2415]

UDC 535.211

EFFICIENCY OF MATERIAL TREATMENT WITH LASER PULSE RADIATION ON HYDRODYNAMICS OF MELT

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 3, May-Jun 84 (manuscript received 16 Feb 82) pp 12-20

VEDENOV, A. A. and GLADUSH, G. G., Moscow

[Abstract] Treatment of materials with laser pulses is analyzed as interaction of radiation and matter, involving wavefront propagation and energy transfer with resulting phase transitions (melting and evaporation) of the

substance followed by further breakdown of the target by various mechanisms. The kinetics of the processes, extrusion flow under vapor pressure or inertial flow, depend on whether the difference $\tau - \tau_c$ between laser pulse duration and time for heating to the boiling point is equal to or shorter than the characteristic time $t_0 = \sqrt{\rho R^2 . 2P_0}$ (ρ- density of target substance, R-radius of laser beam, P_0-pressure at center of melt assumed not to vary in time). Into account are taken the hydrodynamics as well as the thermodynamics, assuming a Gaussian laser beam and formation of a gusher or multiple jet. The specific breakdown energy is calculated as a function of the laser-pulse energy density and as a function of the laser-pulse duration. Normalized general relations are evaluated numerically for steel and a typical laser beam ($R = 10^{-3}$m, $q_i \gtrsim 10^{10}$ W/m^2). This theory is then applied to the dagger mode of target hydrodynamics during welding with a periodic-pulse CO_2-laser, namely for an interpretation of the shifting of the vapor-gas channel as the consequence of liquid overflowing from its front wall to its back wall by any of the possible mechanisms. The authors thank S. V. Drobyazko, V. A. Fromm, Ye. B. Levchenko and A. L. Chernyakov for discussions. Figures 3; references 7: 6 Russian, 1 Western.
[125-2415]

POWDER METALLURGY

TURBULENCE-CHAMBER PROCESS SPEEDS DRYING OF METAL POWDERS

Frunze SOVETSKAYA KIRGIZIYA in Russian 31 Aug 84 p 3

[Article by D.Latypov, correspondent (Vladivostok)

[Text] A. Yedakov, an associate of the Institute of Chemistry of the USSR Academy of Sciences' Far East Research Center, had to begin his powder-metallurgy research 'in an oven.' The oven became an object of close study because it is indispensable in the preparation of metal powders for pressing or spraying on parts.

A paradoxical situation arose in powder metallurgy. Relatively ineffecient methods for drying metal powders have been employed in this field up until now. A layer of powders which is a few centimeters thick is first poured. This 'layer cake' then undergoes heat treatment in a furnace for three to five hours, at a temperature of 150 degrees. It has to be agitated in the process. In the next stage, the powder goes through a so-called pre-reducing cycle. Another two hours are lost in the process.

But can the drying process be accelerated? A Yedakov proposed treating particles of powder in a suspended state. He designed a turbulence chamber for this purpose. Metal powder passes through this chamber in three to five seconds. It comes out ready for pressing and spraying on parts.

The first industrial unit for the drying and pre-reducing of metal powders is now being built at the Arsen'yev Aviation Production Association. Interest in this innovation has been shown also at other enterprises of the Maritime Territory.

FTD/SNAP
CSO: 1842/132

UDC 621.762.4

PRESSING AMORPHOUS ALLOY POWDERS UNDER DYNAMIC CONDITIONS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 84
(manuscript received 6 May 83) pp 17-23

ROMAN, O. V., ADADUROV, G. A., BALDOKHIN, Yu. V., BOGDANOV, A. P. [deceased], VOLOSHIN, Yu. N., GOROBTSOV, V. G., KAPLAN, A. M., MESSINEV, M. Yu. and PIKUS, I. M., Belorussian Republic Scientific-Industrial Department of Powder Metallurgy; Institute of Chemical Physics, USSR Academy of Sciences

[Abstract] An experimental feasibility study was made concerning compaction of amorphous alloy powders by dynamic compression. Dynamic isentropic compression was compared with conventional impact loading, the new method covering a wider range of realizable phase constitutions. A stack of slabs, copper-aluminum-Plexiglas (in the order of decreasing dynamic stiffness $\rho_0 D$, ρ_0 - initial density, D - velocity of shock wave front), was fired by detonation of an explosive charge to strike the powder sample in a mold at impact velocities inversely proportional to the dynamic stiffnesses. Powder samples were thus compacted under pressures from 5 to 20 GPa, compaction within the 7-11 GPa range yielding the essential information about this process, at initial temperatures from 77 to 523°K. Equivalent compaction by repetitive conventional impacts was effected by means of a single copper slab weighing as much as the entire stack used in the other method. Powders of two alloys were the object of this study: (I) $Fe_{40}Ni_{40}P_{14}B_6$ and (II) $Fe_{70}Cr_{10}P_{13}C_7$ with a < 150 μm dispersion attained by crushing 50-μm-thick ribbon with lamellar grain structure. Microstructural examination of specimens by metallography and x-ray diffractometry was supplemented with gamma-resonance spectroscopy in an LP-4840 "Nokia" analyzer using a 20 mCi cobalt-in-chromium source of Mössbauer radiation. Crystallization was monitored calorimetrically. Compaction by either method was found to result in a powder density reaching 96-99% of the bulk density, with the orientation of particles remaining random as initially after conventional impacts and becoming unidirectional parallel to the compression wave front upon dynamic isentropic compression. Compaction of alloy (I) powder at temperatures below 623°K resulted in an appreciable lowering of the crystallization-peak temperature, with retention of most of the metastable amorphous phase for an indefinite time period. Compaction of alloy (II) powder resulted in no structural transformations and no lowering of the crystallization-peak temperature. Figures 5; references 9: 4 Russian, 5 Western. [127-2415]

UDC 536.46:621.76

SELF-PROPAGATING PROCESS OF SINTERING OF ULTRADISPERSED METAL POWDERS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 275, No 4, Apr 84
(manuscript received 29 Jun 82) pp 873-875

IVANOV, G. V., YAVOROVSKIY, N. A., KOTOV, Yu. A., DAVYDOVICH, V. I. and MEL'NIKOVA, G. A., Institute of Petrochemistry and Institute of High-Current Electronics, Siberian Division, USSR Academy of Sciences, Tomsk; Scientific Research Institute of High Voltages, Tomsk Polytechnical Institute

[Abstract] A study is made of the specifics of sintering and certain properties of aluminum and copper powders produced by electric explosion of wires in an atmosphere of hydrogen or argon. The powders were polydispersed systems of particles of spherical shape, mean diameter 0.03 to 1.3 micrometers. The powders were used to press tablets 6 mm in diameter and 1-2 mm high, relative density 0.8-0.9. The tablets were heated at 200 K/min to 1200°K and motion pictures were made to determine the rate of advance of the propagating process of sintering: 1-3 mm/s for copper, 0.5-0.7 mm/s for aluminum. The mechanical characteristics of the tablets produced are approximately the same as those of monoliths. Figures 3; references 7: all Russian.
[103-6508]

UDC 533.9:537.523.5

FEASIBILITY OF PRODUCING ULTRAFINE-DISPERSE POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 84
(manuscript received 18 Nov 81) pp 34-39

RYKALIN, N. N., FEDOROV, V. B., KORTSENSHTEYN, N. M. and PETRUNICHEV, V. A., Institute of Metallurgy, USSR Academy of Sciences

[Abstract] Production of ultrafine-disperse pure metal or other powders by vaporization in a cold plasma and subsequent condensation is analyzed theoretically, most crucial being the initial stage of bulk condensation. The powder characteristics are evaluated through solution of the corresponding equations of kinetics. In the first approximation there is considered a steady uniform flow of a mixture of metal vapor and noncondensing gas, a typical example being a mixture of tungsten vapor and argon. The solution yields the condensate mass concentration profile along the jet as well as the mean dimension of condensate particles and their size distribution function, assuming further that the velocities of both phases are equal. The critical condensate nucleation radius is calculated on this basis, taking into account the presence of ions and the attendant critical supersaturation, first disregarding and then including Brownian coagulation. Typical model calculations made for a vapor-gas mixture (Q_W = 2 kg/h, Q_{Ar} = 3.5 m^3/h) flowing at a constant velocity

($v = 150$ m/s) through a channel of uniform cross section (118.7 mm^2) in the condensation zone, under constant atmospheric pressure and with a longitudinal temperature gradient $(dT/dx)_0 = -200$ K/mm produced by cooling, indicate the feasibility of producing a tungsten powder with the mean dimension of particles as small as 3--5 nm. These calculations are based on classical theory as well as on the theory of homogeneous/heterogeneous nucleation. Figures 5; references 8: 7 Russian, 1 Western.
[127-2415]

UDC 669.15-194.55:620.181:620.184.6

INFLUENCE OF LONG-TERM AGING UNDER STRESS ON PHASE COMPOSITION AND FRACTURE OF 07Kh16N4B STEEL

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 2, Mar-Apr 84 (manuscript received 22 Apr 83) pp 46-50

MAKSIMOVICH, G. G., AZBUKIN, V. G., TRETYAK, I. Yu. and MESHCHERYAKOVA, T. N.

[Abstract] The purpose of this work is to study the influence of long-term aging under stress on the micromechanism of fracture of type 07Kh16N4B steel, its relationship to phase composition and mechanical properties. Specimens used were heat treated by hardening from 1050°C in oil and tempering at 650°C two hours. Tests were performed at room temperature and elevated temperatures. The studies showed that this steel in the high tempered state has good structural stability and increased resistance to embrittlement after long-term aging under stress at 340°C. The effect of external stresses at higher aging temperature facilitates the development of brittleness in the steel.
Figures 3; references 8: 7 Russian, 1 Western.
[108-6508]

TOOL MINISTRY SPURNS NON-TUNGSTEN STEELS AS TOO ECONOMICAL

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Jul 84 p 2

VALENTINOV, A., MELIKOV, D., correspondents (Baku and Moscow)

[Abstract] The lengthy article reports results of the authors' investigation of delays in the production of non-tungsten steels which are said to be capable of replacing costly tungsten steels used in tools for machining the large majority of metal products. The principal developer of the non-tungsten steels, brands "EK-41" and "EK-42". was the Metals Science Special Design and Technological Bureau of the Azerbaydzhan Academy of Sciences' Physics Institute. The head of the bureau is Candidate of Technical Sciences N. Suleymanov. Also involved in the development were the Moscow Higher Technical School imeni Bauman, the Central Scientific Research Institute of Ferrous Metallurgy imeni Bardin, and the Institute of Metallurgy imeni Baykov.

The authors found that the problem with getting the steels into tool production lies with the All-Union Scientific Research Tool Institute (VNIIinstrument), which is a chief institute of the Ministry of the Machine Tool and Tool Industry (Minstankoprom). In 1978 the developers of the steels prevailed upon VNIIinstrument, although it had not been involved in the development, to conduct tests of drill bits made of the non-tungsten steels. The tests reportedly proved the steels to be capable of replacing tungsten steel bits. The authors observe:

"It would seem that [at that point] the institute...would have set about doing what is supposed to be its job: testing the new steels, developing the tool-manufacturing technology, finding applications and determining optimal machining conditions, organizing series production and introducing the tools. But the technical administration of Minstankoprom, citing the opinion of VNIIinstrument, refused to undertake this work. They armed themselves with a new 'argument'--that the use of the non-tungsten steels does not bring the desired advantages. Here it is appropriate to ask: for whom? After all, in series production the new steels will be substantially cheaper than tungsten ones. Also, since their weight is less, it is possible to produce 4 percent more tools. But these are advantages which are beneficial primarily to customers. And for the manufacturers? For them, expensive materials guarantee high costs of tools and consequently a solid 'growth' in the volume of production in terms of rubles."

FTD/SNAP
CSO: 1842/132

'AZOVSTAL' MAKING LARGER SHEET FOR SHIPBUILDING

Kiev RABOCHAYA GAZETA in Russian 6 Sep 84 p 2

[Article by O. Tokhtomysh]

[Text] Metalworkers of the Azov Steel (Azovstal') Complex have begun carrying out an important assignment. The filling of a large order for rolled steel sheet for restoring the hull of the cruiser "Aurora" has begun here.

Not by chance did the Leningrad shipbuilders place one of their orders at the 'southern Magnitogorsk.' Large-capacity facilities have been created along the entire production line here. These facilities make it possible to obtain metal of high quality and with strict specifications. The capabilities of the unique "3600" mill were also expanded recently. As a result of its modernization, sheets with larger dimensions can be produced on it. This will reduce the number of butt welds substantially and cut the time for assembling ships.

Metal from the "Azovstal'" metalworkers will serve reliably in hulls of icebreakers, structures of bridges, deep-level foundations of offshore oil drilling complexes, and pipelines in the North. These workers will supply more than 1,000 tons of heat-hardened sheet to the Leningrad Shipbuilding Plant imeni Zhdanov, for the renovation of the legendary cruiser.

FTD/SNAP
CSO: 1842/132

PROCESS FOR OBTAINING NON-TUNGSTEN TOOL STEELS

Riga SOVETSKAYA LATVIYA in Russian 11 Jul 84, p 4

[Excerpt] N. Suleymanov, who is director of the Azerbaydzhan Academy of Sciences' special design and technological bureau of metals science "Kristall" in Baku, has succeeded in developing a high-speed non-tungsten steel while lowering the metal's molybdenum content by one-half to one-tenth as well, This steel was developed with the participation of scientists of the Moscow Higher Technical School imeni Bauman and the Institute of Ferrous Metallurgy imeni Bardin. Some makes of steel contain no molybdenum at all. Moreover, the durability of tools made of these steels is increased by two to three times.

The point is that the hardness of a steel is determined by the presence of the simplest carbides of refractory metals in it. Tungsten has been replaced by vanadium and titanium, which are relatively inexpensive and plentiful.

The quality of a steel depends not only on its chemical composition but also on heat-treatment conditions. Instead of a quenching and two to three temperings (the standard process for hardening steel), a double quenching with isothermal holding was proposed. Following this treatment, complex carbides break down into the simplest ones and the concentration of carbon decreases, which heightens the metal's ductility and impact strength. As a result, the steel acquires paradoxical properties: it is hard but not brittle!

FTD/SNAP
CSO: 1842/132

UDC 539.4.011.25:669.294.715:539.382.2

FEATURES OF PLASTIC DEFORMATION AND FRACTURE OF EP 741 NICKEL ALLOY UNDER THERMAL STRAIN

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 84
(manuscript received 3 Jan 83) pp 51-57

GERASIMOVA, L. P., GODOVANETS, M. A., KOTOV, V. F., POPOVA, L. Ye. and SHVARTS, V. I., Moscow

[Abstract] Plastic deformation and fracture of the EP 741 heat-resistant nickel alloy for runners of gas turbines were studied under conditions of thermal strain typical of runner operation, at room temperature and at 750°C. Both powder and wrought forms of this alloy were tested, for a comparative evaluation of their mechanical characteristics. The test results, together with thermomicroscopic and electron-microscopic examination, revealed substantial differences in the microstructure and the behavior of the two materials. After plastic deformation and fracture, powder specimens were found to have much smaller grains, one order of magnitude smaller than grains in wrought specimens, with sinuous and therefore much longer grain boundaries but without large carbide deposits. At the same time, powder specimens contained larger γ'-phase grains (0.5 μm) with sharp, predominantly rectangular, rather than round contours. Plastic deformation was found to produce slip bands enveloping the γ'-phase in a staircase fashion, especially in regions depleted of the γ'-phase solid solution, the γ'-phase thus inhibiting crack propagation in the powder material. An analysis of the kinetics indicates combination intercrystalline and intracrystalline fracture of the powder alloy, following a predominantly plastic microdeformation under tensile stress. The powder alloy has comparable strength characteristics and much better plastic characteristics, with higher toughness, than the wrought alloy. Figures 5; references 1 Russian.
[127-2415]

UDC 620.18:669.245

STRUCTURAL STABILITY OF NICKEL HEAT RESISTANT ALLOYS AT HIGH TEMPERATURES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 84 pp 36-39

PETRUSHIN, N. V., LOGUNOV, A. V. and GORIN, V. A.

[Abstract] The purpose of this work was to determine the temperature of dissolution of the hardening γ' phase in the nickel solid solution of EP742 heat resistant alloy. The temperature was determined by the method of electroresistance upon heating of specimens from normal temperature to 95% of the melting point. Analysis indicates that as the quantity of γ' phase in the alloy increases, resistivity increases. This is retained at elevated temperatures right up to the beginning of dissolution of the γ' phase. A decrease in resistivity of nickel heat resistant alloys at temperatures near 900°C may be related to the decrease in volumetric fraction of the phase component which has the greatest resistivity as well as a decrease in the resistivity of the γ' phase itself in this same temperature interval. The temperature of full dissolution of the γ' phase in this alloy is greatly influenced by the content of aluminum and of titanium. Figures 3; references 11: 9 Russian, 2 Western. [118-6508]

UDC 539.216.2:538.221.001

TWISTED DOMAIN WALL IN VERY THIN MAGNETIC FILMS WITH PERPENDICULAR ANISOTROPY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 1, Jul 84 (manuscript received 11 Oct 83) pp 37-41

KHODENKOV, G. Ye., Institute of Electronic Control Machines

[Abstract] The theory of twisted domain walls for magnetic films thicker than the Bloch line is extended to very thin magnetic films. Solution of the corresponding two second-order differential equations of energy, which include terms accounting for exchange interaction and uniaxial anisotropy as well as magnetostatic energy consisting of a local component and a long-range component associated with surface charges, reveals that in this case the twist angles are small so as to make a free domain wall a quasi-Blochian one. The maximum steady-state velocity of such twisted domain walls, calculated from the conventional variational equation, approaches here the Walker limit and is higher than the velocity at saturation in thick magnetic films. All calculations here can be made analytically, which is not possible in the case of thick magnetic films. References 6: 3 Russian, 3 Western.
[155-2415]

UDC 539.216.2:538.221.001

SOME MECHANISMS OF DOMAIN WALL PINNING IN THIN MAGNETIC FILMS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 1, Jul 84 (manuscript received 4 Jul 83) pp 11-20

IVANOV, A. A., LOBOV, I. V. and VOROB'YEV, Yu. D., Krasnoyarsk Pedagogical Institute

[Abstract] Domain wall pinning in thin magnetic films is analyzed from the standpoint of wall-defect interaction. Calculations are based on three possible combinations of domain wall model and defect arrays: 1) plane domain wall and regular orientation of defects; 2) plane domain wall and random orientation of defects; 3) filar domain wall and random orientation of defects. Expressions are derived for the pinning force and the coercive force in each case. Euler's summation rule is applied to interaction forces in a regular cubic crystal lattice, dispersion and mean wavelength of the interaction force

are included for defects with random orientation. Refinements are made to take into account disoriented axes of easy magnetization as well as the existence of grain boundaries, pores, and surface unevenness. References 7: 5 Russian, 2 Western.
[155-2415]

UDC 621.382.008

EFFECT OF HEAT TREATMENT ON PHASE COMPOSITION AND CRYSTAL STRUCTURE OF THIN WSi_2 FILMS ON SILICON SUBSTRATES

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 6, Jun 84 (manuscript received 22 Dec 82, final edition received 20 Dec 83) pp 97-102

BIRYUKOV, Ye. P., DOSTANKO, A. P., MAL'TSEV, A. A. and SHAKHLEVICH, G. M., Minsk Institute of Radio Engineering

[Abstract] An experimental study of WSi_2 films on silicon substrates with either <111> or <100> orientation was made, for the purpose of determining the effect of annealing by heat treatment on their phase composition and crystal structure. Films of 0.2 μm thickness were deposited at a rate of 0.5 nm/s on a silicon surface which had been predecontaminated of SiO_2 layers and adsorbate atoms by ion sputtering in one vacuum cycle. They were deposited by condensation, with the substrate held at various temperatures from 390 to 500°C, and then annealed in an argon atmosphere at various temperatures from 700 to 1000°C for 30 min. Subsequent phase analysis at room temperature was performed with a DRON-2 x-ray diffractometer, using a CuK_α-radiation source and covering the 2θ = 10-130° range of angles by the Debye-Sherer method, while the surface morphology was examined under an electron microscope. The results revealed a polyphasality of the condensate, the principal component WSi_2 being accompanied by W_5Si_3 as well as by W and Si. This is attributed to the differences in respective phase formation temperatures rather than to partial dissociation of WSi_2. Namely, W_5Si_3 forms at 200-400°C and WSi_2 forms at 500-700°C so that condensation of a Si:W = 2:1 mixture on a substrate at a temperature below 500°C can produce both silicides and the fraction of WSi_2 will increase as the annealing temperature is raised. Annealing was found to appreciably improve the crystal structure of the films, with an attendant homogenization. With higher annealing temperature or longer annealing time, the reflexes of the W_5Si_3 phase and of polycrystalline Si become weaker, while the reflexes of the WSi_2 phase become more intense and narrower. There is a marked difference between films on silicon substrates with <100> orientation and with <111> orientation, respectively. Recrystallization of WSi_2 films on <100> substrates weakens the axial grain orientation and annealing at 1000°C for 30 min reduces the P[001] pole concentration factor to 1.37, x-radiograms of such films becoming similar to those of a reference powder target annealed in

vacuum at 1300°C. Recrystallization of WSi_2 films on <111> substrates under conditions of minimum lattice distortion intensifies their [001] grain orientation, which eventually replaces all other preferential orientations, and annealing at 1000°C for 30 min increases the P[001] pole concentration factor to 4.66 (while reducing the P[112] pole concentration factor to 1.07). Figures 4; references 14: 9 Russian, 5 Western (1 in Russian translation). [129-2415]

UDC 539.2

ONE-DIMENSIONAL MODEL OF THIN FILMS. ANALYSIS OF ALUMINUM SURFACE

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 6, Jun 84 (manuscript received 11 Feb 83, final edition received 11 Oct 83) pp 43-46

BEZRYADIN, S. N., VERNER, V. D. and YEGOROVA, T. I., Moscow Institute of Electronic Engineering

[Abstract] A self-consistent one-dimensional model with a potential depending on the crystal structure is proposed for analysis of crystalline surface films, in lieu of the "jelly" model and full three-dimensional equations. The three components of the electron-film interaction potential account for electron-ion interaction, exchange-correlational interaction, and Coulomb interaction of valence electrons respectively. The potential of an ion does not change, in the first approximation, as the ion is transported from inside the crystal to the surface. Therefore, any tabulated pseudopotential with a form factor accounting for Coulomb interaction of valence electrons is suitable for calculations. Density of valence electrons rather than overall electron density is referred to, the latter being approximately the sum of atomic electron densities calculated on the basis of hydrogen-like atomic wave functions. The corresponding Schroedinger equation is solved in the momentum space. For an analysis of the aluminum surface according to this model, calculations have been made using the Animalu-Heine-Abarenkov pseudopotential and the Slater X_α method, with self-consistency within third-order accuracy with respect to the charge distribution. Oscillations of the electron density were found to extend deeper below the surface. Close agreement with experimental data was obtained for the nonrelaxing (100) surface. Relaxation of both (110) and (111) surfaces must be taken into account, and has been in calculations for four-layer and eight-layer aluminum films. Relaxation affects the wave functions at the film surface and thus also the electron density, but the latter only at the surface. At a depth of three lattice periods below the surface the difference between electron densities calculated with and without relaxation of the surface does not exceed 2%. The discrepancy between experimental and theoretical results with relaxation accounted for is attributable to imprecise evaluation of the Coulomb interaction between valence electrons, which depends on the assumed electron density distribution in the crystal. Figures 2; references 11: 3 Russian, 8 Western.
[129-2415]

UDC 539.43:669.715:620.191.33.0.01

KINETICS OF FATIGUE FACTOR OF AT3 TITANIUM ALLOY IN AIR, DISTILLED WATER AND 3.5% AQUEOUS NaCl SOLUTION

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 2, Mar-Apr 84 (manuscript received 20 Feb 83) pp 17-22

BOTVINA, L. R., YAREMA, S. Ya., OSTASH, O. P. and POLUTRANKO, I. B. Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow; Institute of Physics and Mechanics, imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] Results are presented from the study of the development of fatigue cracks in AT3 titanium alloy upon testing in air (relative humidity 50-70%), distilled water and a 3.5% NaCl solution. Results are compared with data from quantitative analysis of fracture microrelief. Alloy composition: 2.0-3.5% Al, 0.2-0.5% Cr, 0.2-0.4% Si, 0.2-0.5% Fe, remainder Ti. Disk specimens were prepared from rolled sheets 7 mm thick, specimen diameter 230 mm, thickness 4 mm, with a central crack for testing in uniaxial extension. It is found that distilled water and 3.5% NaCl have little influence on cyclical strength of AT3 alloy. Beginning at a certain load level there is a break on the kinetic fatigue fracture diagram and elements of static fracture appear on the fracture surface. Figures 3; references 9: 7 Russian, 2 Western.
[108-6508]

UDC 669.295

STUDY OF STRUCTURE OF SPONGE TITANIUM VARIETIES

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 2, Mar-Apr 84 (manuscript received 10 May 83) pp 33-38

LIKHTERMAN, V. A., POZDNYAKOV, A. N., deceased, SHIRYAYEV, R. Ye., KHALIMOV, F. B., GONCHARENKO, T. V. and GOLUBEVA, O. A., Leningrad Institute of Mining, Department of Light and Rare Metals

[Abstract] A study is made of the structural specifics of defective varieties of sponge titanium as compared to technically pure titanium. Analysis was performed by mercury porometry, quantitative image analysis, thermal desorption of argon and electron microscopy. The studies indicated

the variety of structural characteristics of technically pure and impure sponge titanium. Even a single variety showed significant differences in surface morphology, porosity and specific surface as functions of structure. This results from differences in parameters of technological processes, initial raw material quality and location of specimen in the sponge titanium block. Structural characteristics therefore cannot be the only characteristics for rapid defectoscopy of sponge titanium lumps. Figure 1; references 8: all Russian.
[107-6508]

UDC 669.017

TITANIUM ALLOYING SYSTEMS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 2, Mar-Apr 84 (manuscript received 15 Dec 82) pp 92-98

KOLACHEV, B. A., LYASOTSKAYA, V. S., Moscow Institute of Aviation Technology, Department of Metallography and Hot Working of Metal

[Abstract] A system is suggested for more detailed classification of titanium alloys. The alloying elements are represented as follows: A - α stabilizer; N - neutral hardeners; β stabilizers: B_i - isomorphic; B_{ep} - eutectoid-forming, strong β stabilizing transition elements; B_{ea} - active eutectoid forming. A table lists suggested alloy type designations and compositions. Coefficients are suggested which provide an approximate estimation of the β stabilization level of titanium alloys, though they do not consider the influence of α stabilizers or neutral hardeners. References 11: 6 Russian, 5 Western.
[107-6508]

UDC 620.18:620.17:669.295.5

STRUCTURE OF TWO-PHASE TITANIUM ALLOYS WITH DIFFERENT MICROSTRUCTURES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 84 pp 55-57

FEDOTOV, A. S., All-Union Institute of Aviation Machine Building

[Abstract] This review of the literature discusses two-phase titanium alloys. Three types of microstructures are included. The first group is alloys with globular α phase separated by interlayers of β phase. The second group includes alloys with so-called β-converted microstructures consisting of plates of α phase separated by interlayers of β phase. Interlayers of β phase may be present along the boundary of the former β grain. The third group includes alloys with a mixed structure. The properties of the alloys are divided into

two groups characterizing the resistance of the alloy to fracture under the influence of static and cyclical loads. The mechanism of fracture of two-phase titanium alloys under the influence of static and of cyclical loads is described. An increase in toughness of fracture of specimens with a microstructure including the plate component is observed, resulting from the increase in crack path length due to the convolution of the path and the increase in the force necessary to cause a crack to propagate. The birth of a fatigue crack is facilitated by the transformed component of the microstructure present; the time before the formation of the first crack is thus reduced. To assure effective resistance of titanium alloys to the formation of fatigue cracks, the dimensions of α grains and the length of their boundaries must be decreased. The equiaxial form of α particles in this case is preferable. References 15: 8 Russian, 7 Western.
[118-6508]

UDC 669.295:669-156:536.42

STRUCTURAL RECRYSTALLIZATION IN TITANIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 1, Jul 84 (manuscript received 27 Apr 83) pp 69-75

MIRZAYEV, D. A., SCHASTLIVTSEV, V. M., SHTEYNBERG, M. M. and UL'YANOV, V. G., Chelyabinsk Polytechnic Institute imeni Lenin Komsomol; Institute of Metal Physics, Ural Science Center, USSR Academy of Sciences

[Abstract] An experimental study of β→α→β transformations in titanium was made for the purpose of determining the dependence of the β-phase grain size after a single α→β transformation and of the α-phase recrystallization during annealing on the quenching rate. Specimens of titanium were produced by the iodiding process and resmelting with an electron beam. Strips cut from ingots were cold-rolled from 2 mm to 0.13 mm thickness. After annealing at 1000°C under a vacuum of 0.4 mPa for 20 min and subsequent cooling in a furnace at a rate of 1°C/s, the sheet specimens were again rapidly heated to 1000°C under vacuum and held at that temperature for 3 s before being quenched at various rates ranging from 10°C/s to $35 \cdot 10^4$°C/s. The β→α transformation temperature was determined from the bend along the cooling curve, the latter having been recorded with Chromel-Alumel thermocouples. Strain widening of the 220 CuK_α interference line was measured by x-ray structural analysis, in addition to measurements of microhardness and grain dimensions. The results reveal that the mode of structural recrystallization during α→β transformation does depend on the quenching rate, the grain size remaining unchanged in titanium which has quenched slowly at rates up to 10^4°C/s but being decreased in titanium which has been quenched faster. Recrystallization of α-phase titanium during annealing can occur, when earlier quenching has produced martensite in the form of either lamellas (10^4-$8 \cdot 10^4$°C/s) or twin crystals ($8 \cdot 10^4$-$35 \cdot 10^4$°C/s). Figures 4; references 9: all Russian.
[155-2415]

UDC 669.295'71:548.4

ENERGY OF STACKING FAULT AND DISLOCATION STRUCTURE OF TITANIUM ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 1, Jul 84 (manuscript received 25 Jan 83, after final editing 30 May 83) pp 76-80

PETROV, Yu. N., SVECHNIKOV, V. L. and NADEZHDIN, G. N., Institute of Metal Physics and Institute of Strength Problems, UkSSR Academy of Sciences

[Abstract] Buildup of stacking faults in the form of lengthy dislocation nodes in pure α-titanium and in its substitutional alloys with molybdenum, vanadium, or aluminum is analyzed theoretically, a principal factor being the energy of such a fault and its temperature dependence. Earlier electron-microscope examination of α-titanium and titanium-aluminum alloys produced by electron-beam resmelting of iodided titanium has revealed an absence of triplet dislocation nodes in a cph lattice but a presence of lengthy dislocation nodes inside dislocation twins or martensite lamellas, particularly in titanium-aluminum alloys with more than 6 wt.% Al corresponding to Ti_3Al and TAl compositions. The stacking-fault energy in a binary alloy is calculated as the sum of matrix energy $\gamma_b = \frac{1}{2\bar{V}^{2/3}} [\Delta G_{Ti}(1-x_a)+\Delta G_a x_a+\Delta W_{Ti,a} x_a(1-x_a)]$ and segregation energy $\gamma_s = \frac{1}{2\bar{V}^{2/3}} \Delta G_s$, the latter being related to chemical free energy, elastic free energy, and surface free energy differences ($\bar{V}$ - molar volume of alloy, ΔG - difference between free energy of cph phase and free energy of fcc phase, ΔW - difference between interaction parameters of the two components in solid solution, x_a - concentration of Al, V, or Mo). Calculations for two temperatures, 100°K and 600°K, yield results which qualitatively agree with available experimental data on the structure of these titanium alloys. They confirm that, within the respective solubility ranges, molybdenum and vanadium increase the stacking-fault energy while aluminum decreases it. These changes become larger with rising temperature. Figures 2; references 19: 3 Russian, 16 Western (5 in Russian translation).
[155-2415]

UDC 669.295.293:620.186.1

CONTROL OF STRUCTURE OF TWO-PHASE TITANIUM ALLOYS DURING THERMOMECHANICAL TREATMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 84 pp 53-55

KADYKOVA, G. N., Moscow Institute of Electronic Machine Building

[Abstract] The purpose of this work was to develop a method of producing structures with homogeneous distribution of α-phase particles in cold deformed

(α+β) alloys. The results of x-ray and electron microscope studies of Ti+35% Nd + 33% Zr alloy subjected to various preliminary treatment followed by cold deformation with 98% compression and aging at 400°C four hours showed that the phase composition and structure of the specimen differed significantly. After all treatments the structure of the specimens was inhomogeneous. Seeds of the α and ω phases obtained in (α+β) titanium alloys in the process of hardening and aging are retained upon cold deformation and become centers of growth of these phases during subsequent aging. This allows more uniform distribution of α-phase in cold-deformed alloys. References 4: 3 Russian, 1 Western.
[118-6508]

UDC 620.18:620.178.322.3:669.295.5

ESTIMATE OF FATIGUE RESISTANCE OF LARGE BLANKS OF VT3-1 TITANIUM ALLOY CONSIDERING MATERIAL STRUCTURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 84 pp 49-51

STEPANOV, M. N., VEYTSMAN, M. G., AGAMIROV, L. V., GIATSINTOV, Ye. V., and GUS'KOVA, L. N.

[Abstract] The purpose of this work was to estimate the influence of manufacturing technology and structure of VT3-1 titanium alloy on fatigue resistance of large blanks 200 to 400 kg in mass. Statistical processing of fatigue testing results shows that different technological systems of manufacturing blanks significantly influence mean values of number of cycles to failure. When different types of blanks are made by the same technology, their characteristics also differ. The forging parameters within a single technological scheme should be established for each type and size of blank worked. Great heterogeneity of macrostructure and microstructure are characteristic for large blanks. Macrograin size, nature and homogeneity of microstructure are largely determined by the technology of manufacture of semifinished goods.
[118-6508]

UDC 620.17:620.18:669.295.5

INFLUENCE OF GLOBULAR STRUCTURE PARAMETERS ON MECHANICAL PROPERTIES OF VT3-1 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 84 pp 46-49

BRUN, M. Ya., SHAKHANOVA, G. V., RODIONOV, V. L. and SOLDATENKO, I. V.

[Abstract] This article presents the results of investigation of VT3-1 alloy with globular type structure. Quantitative metallographic analysis was performed and mechanical properties determined for alloys with variations in each

of the main parameters (primarily α phase particle size, thickness of secondary α phase plate and ratio of primary to secondary α phases). The data obtained permit preliminary determination of optimal globular structure parameters, providing mechanical properties required in the technical documents, as well as properties not yet regulated but required for various operating conditions. The results can be used to regulate the structure in order to improve its properties. The results indicate the desirability of using different heat treatments for products to be used under different conditions so as to produce dimensions of structural components providing the maximum level of those properties most important in each specific case. References 4: all Russian.
[118-6508]

UDC 620.18:620.17:669.295.5

STRUCTURE AND PROPERTIES OF TITANIUM ALLOYS AFTER ISOTHERMAL DEFORMATION AT LOW SPEEDS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 84 pp 43-46

MOISEYEV, V. N., POVAROV, I. A. and KAPLIN, Yu. I.

[Abstract] A study of the change in structure of titanium alloys of various types in the temperature deformation interval from 600 to 1000°C at rates of 0.2-200 mm/min with overall deformation 25-75% establishes the optimal parameters for processing each of the alloys studied (VT6, VT14, VT22 and VT32). The optimal temperature for deformation is some 20°C below the $\alpha+\beta\rightleftarrows\beta$ transition for alloys of subcritical composition, while for more highly alloyed metals it is in the 820-750°C interval. Deformation rates are determined primarily by specific metal flow pressure and the output of the pressing equipment. The specific metal flow pressure depends on the temperature of polymorphous transformation of the alloy and the strength of the α and β phases at the deformation temperature. Decreasing deformation rate decreases specific metal flow pressure, particularly at lower $\alpha+\beta\rightleftarrows\beta$ transition temperatures. Titanium alloys of supercritical composition with soft α + β structural components are therefore of the greatest interest for isothermal deformation at low speeds and low temperatures. Isothermal deformation at $1\cdot10^{-3}$ S^{-1} or less and 700°C was used to produce parts with minimum tolerances and good filling of the mold with good surface quality. Figures 4; references 4: all Russian.
[118-6508]

UDC 539.4

INFLUENCE OF TEMPERATURE ON STRENGTH AND FAILURE OF VT14 TITANIUM ALLOY IN SPALLING

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 2, Mar-Apr 84 (manuscript received 15 Jan 82) pp 112-113

GOLUBEV, V. K., NOVIKOV, S. A., SOBOLEV, Yu. S. and YUKINA, N. A., USSR State Committee for Nuclear Power Research, Moscow

[Abstract] Loads corresponding to the generation of spalling microscopic damage sites in VT14 titanium alloy are calculated and specimens are metallographically analyzed in order to establish the influence of temperature on the nature of spalling. Disks 10 mm thick and 70 mm in diameter were cut from a bar as delivered, specimens loaded by impact with an aluminum plate and the known impact speed correlated to calculated pressure in the loading compressive pulse. Reflection of the compressive pulse from the rear surface of the specimen as a pulse of extension caused fracture of the material. The structure of the specimens was studied using a polished section after etching in aqueous solutions of nitric and hydrofluoric acid. The results of the metallographic studies allow estimation of the microscopic toughness of the material at elevated temperatures. Figures 3; references 5: 4 Russian, 1 Western. [108-6508]

UDC 661.882:669.295

HARDENING OF TITANIUM ALLOY SURFACES BY LASER ALLOYING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 84 pp 12-13

LAKHTIN, Yu. M., KOGAN, Ya. D., TEPLOVA, L. A., TUMANOVA, T. A., Moscow Institute of Motor Vehicles and Roads

[Abstract] Laser heat and chemical-heat treatment such as laser carboboriding and carbosiliciding can be used to improve the properties of titanium alloys. A pulsed laser installation with a pulse length of 3-6 ms and wavelength 1.06 μm, radiation energy range 5-20 J, hardening zone overlap 30-40% was used in the study. Phase analysis of the surface was performed after laser treatment. A 50% solution of BF-2 glue and acetone was used to spread the materials over the surface of the alloy for laser alloying. Directing a stream of nitrogen to the laser heat treatment area increased the microhardness of the surface zone to H856-894 as opposed to 322-356 initial value. After laser heat treatment in air the wear resistance of titanium alloys was increased by a factor of between 1.3 and 50. The corrosion resistance of AT6 alloy in 40% H_2SO_4 was 1.4-1.5 times greater after laser carbosiliciding, 1.6 times greater after laser carboboriding.
[118-6508]

UDC 621.791.72.011:669.24'26.046.5.054.8

DEPENDENCE OF WELDABILITY OF EP693 AND EP199 ALLOYS ON COMPOSITION OF CHARGE MATERIALS IN LADLE

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 84
(manuscript received 25 May 83, final edition received 15 Sep 83) pp 53-56

SOROKIN, L. I., candidate of technical sciences, TUPIKIN, V. I., engineer, IRININ, A. M., candidate of technical sciences, and ZORIN, N. Ya., engineer, Moscow

[Abstract] Heat-resistant alloys are produced more economically by use of tailings, to save on raw materials, but the thus increased impurity content including nonmetallic inclusions can appreciably degrade the weldability of these alloys. A study of two such alloys, EP693 (KhN68VMTYuK) and EP199 (KhN56VMTYu), was made for the purpose of determining the dependence of the strength of their welded joints on the composition of the charge material. Two batches of each alloy were produced in an open induction furnace without preliminary heat treatment but with subsequent vacuum smelting: one batch using only pure ingredients, one batch with tailings constituting 70% of the charge (25% chips, 45% lumps). Ingots were forged and hot-rolled at 950-1100°C, some to a 12-mm thickness and some to a 2-mm thickness, for subsequent joining by electric-arc welding in an argon atmosphere with a refractory electrode without additive. Mechanical properties and, particularly, resistance to hot cracking were determined on 12-mm-thick specimens cut across the seam, after heat treatment of the joints at 800°C for 4 h followed by air cooling. Hot cracking in the seam metal as well as in the base metal was monitored, along with measurement of mechanical strength, plasticity, and toughness. Amounts of sulfur and phosphorus up to 0.025%, copper up to 0.05%, calcium up to 0.055%, lead up to 0.007%, and nitrogen up to 0.07% were found not to influence the rate of γ'-phase precipitation and thus the resistance to hot cracking during dispersion hardening. Unless tailings are refined so as not to contain larger amounts of these elements, the resulting alloy will form welded joints with up to 25% lower resistance to hot cracking and up to 15% lower heat resistance. Amounts of carbon above 0.1%, silicon above 0.6%, and iron above 5% were found to decrease the rate of γ'-phase precipitation and thus increase the resistance to cracking in the joint, with some sacrifice in ultimate strength of the base alloy. While calcium and lead increase the plasticity and the toughness, to a limited degree, copper increases only the toughness of a welded joint. Figures 5; references 7: 5 Russian, 2 Western (1 in Russian translation). [128-2415]

UDC 621.791.72.052:620.18:669.295

STRUCTURE AND DUCTILITY OF FRACTURE OF JOINTS PRODUCED BY ELECTRON-BEAM WELDING OF VT6ch TITANIUM ALLOY PARTS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 5, May 84
(manuscript received 7 Jul 82, final edition received 18 Jan 84) pp 38-40

Academician TREFILOV, V. I. (UkSSR Academy of Sciences) and TURTSEVICH, Ye. V., candidate of physico-mathematical sciences, Institute of Problems in Material Science, UkSSR Academy of Sciences, GUREVICH, S. M. [deceased], doctor of technical sciences, and SHEVELEV, A. D., candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences

[Abstract] Fracture of titanium alloys following plane deformation is known to be ductile, the degree of ductility being determined by the critical stress intensity coefficient, while welded joints of titanium alloys have a low degree of plasticity, as a consequence of structural and phase transformations in the seam and within thermal influence zone. One known technique of ensuring high plasticity of the joint without loss of strength is annealing under low residual pressure at 900°C for 30 h. A study of joints produced by electron-beam welding of VT6ch titanium alloy parts and annealed according to this technique was made before and after fracture by an eccentric tensile load. Plates 60 mm thick were welded at a rate of 60 m/h by an electron beam with a current of 430 mA at an accelerating voltage of 60 kV. The joints were then annealed under a pressure not exceeding 2.66 mPa, with subsequent cooling at a rate of 4°C/min. Structural and fractographic examination of foils cut from seams and base metal were performed under a UEMV-100BR electron microscope with an accelerating voltage of 100 kV and under a JSM-35 scanning electron microscope, respectively. The ductility of fracture was measured on 50-mm-thick specimens according to the stress intensity criterion. The results reveal a ductile fracture of joints whether annealed or not, with a serrate surface relief produced by intercrystalline fracture in annealed seams and caused by intracrystalline fracture in unannealed base metal. Evidently annealing at 900°C produces an α-phase along grain boundaries in the seam. Mechanical tests of joints before fracture indicate that annealing reduces the yield strength and the ultimate strength of both seam and base metal only slightly, while it increases their percent elongation and percent reduction before fracture with the critical stress intensity index raised typically from 2600 to 4500 MPa·mm$^{1/2}$ for the seam metal and from 3900 to 4620 MPa·mm$^{1/2}$ for the base metal. Figures 3; references 6: 5 Russian, 1 Western.
[126-2415]

UDC 621.791.4.05:539.378.3:(669.295+669.15-194.56/57):539.4

CAUSES OF STRENGTH REDUCTION IN WELDED TITANIUM-STEEL JOINTS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 84
(manuscript received 8 Aug 83, final edition received 4 Jan 84) pp 17-19, 22

LARIKOV, L. N., doctor of technical sciences, BELYAKOVA, M. N., candidate of technical sciences, and BIBIKIN, A. A., engineer, Institute of Metallography, UkSSR Academy of Sciences; ZMAKOV, V. N., doctor of technical sciences, and KIREYEV, L. S., engineer, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences

[Abstract] Diffusion welding of VT1-0 industrial-grade titanium to 2Kh13 ferritic steel or to 12Kh18N10T austenitic steel under other than optimum conditions (welding time 2-3 min at temperature of 650°C and under pressure of 400 MPa) has been found to produce joints of lower strength, even though with the same phase composition. While the dependence of ultimate strength on welding time is almost the same for both titanium-steel pairs, the strength of titanium alone being reached by welding for less than 60 s and not more than 200 s, in a VT1-0/2Kh13 joint first titanium deforms and then the steel does but in a VT1-0/12Kh18N10T joint only titanium deforms. During welding under pressure titanium macrodeforms initially by twinning and slipping, followed by recrystallization at high strain levels. A subsequent study was made in search of an explanation for the lower strength of joints produced by prolonged welding at the optimum temperature and of joints produced by welding within the optimum time at a higher temperature of 800°C. In the first case the strength of joints was found to be determined by the strain distribution and the cracking pattern following recrystallization. In the second case the strength reduction was found to be attributable to precipitation of complex carbides. No titanium-iron and titanium-nickel intermetallic compounds were revealed in VT1-0/12Kh18N10T compounds by x-ray spectral analysis. Figures 8; references 8: 7 Russian, 1 Western (in Russian translation).
[128-2415]

PLASMA-ARC REMELTING OF TITANIUM ALLOY SCRAP

Kiev RABOCHAYA GAZETA in Russian 12 Jul 84, p 2

[Article by A. Kovalenko, correspondent]

[Text] Specialists of the Kommunarsk Metallurgical Plant, with the collaboration of scientists of the Ukrainian Academy of Sciences' Institute of Electric Welding imeni Paton, have developed and introduced a process for plasma-arc remelting of waste products of the titanium alloy that is used to manufacture equipment for deposition of high-strength anticorrosive coatings.

Specialists estimate that the use of one plasma-arc furnace for the recycling of titanium scrap will result in savings of 300,000 rubles annually.

FTD/SNAP
CSO: 1842/132

LASER R&D AT WELDING EQUIPMENT INSTITUTE

Leningrad LENINGRADSKAYA PRAVDA in Russian 19 Aug 84 p 2

[Article by M. Fadeyeva]

[Excerpt] "A laser makes it possible to accomplish several tasks at once, as a complex," related S. K. Kartavyy, head of the department of specialized welding methods of the All-Union Scientific Research Institute of Electric Welding Equipment (VNIIESO). "It can weld, cut and do heat treating and hard facing."

Since 1977, two laboratories in this department--the laser equipment and laser technology laboratories--have been engaged in developing multipurpose units for the welding, cutting and heat treatment of metals. Specialists of these laboratories have worked with scientific research institutes and plants to jointly develop 14 test prototypes of equipment in seven years.

The first demonstration of the laser's broad capabilities took place in 1982 at the international exhibition "Elektro-82" in Moscow, where laser equipment built by the Leningrad specialists and the Novosibirsk Institute of Theoretical Applied Mechanics was demonstrated.

Two types of units--one with multipurpose pulsed-periodic action and a continuous-radiation unit--are now being developed in the two VNIIESO laboratories under the direction of their heads, L. A. Shterin and V. S. Smirnov. A number of test prototypes will be sent to various scientific research institutes for further testing; the rest will be turned over to enterprises where laser-quipment sections have been created with the assistance of specialists of the laboratories.

The new technology has indisputable advantages. The laser has no rivals in the technological operations of cutting thin-sheet materials 1 to 5 millimeters thick and of hard-facing metal. The laser equipment's production capabilities are expanding as its power increases. The continuous-radiation unit, which has a power of 5 kilowatts, thus permits highly effective welding, cutting and heat treatment of materials up to 8 millimeters thick.

FTD/SNAP
CSO: 1842/132

COMPACT WELDING APPARATUS WITH SOLAR POWER SUPPLY

Kiev RABOCHAYA GAZETA in Russian 23 Aug 84, p 1

[Text] Ashkhabad--A compact device which Turkmen specialists have developed is being used instead of bulky gas welding apparatus for welding girders in the Karakumy Desert. This device produces gas from ordinary water by utilizing the sun's energy. A welder can now travel with only a small case to a place where he is called. After all, there are water and sunshine at every well.

The conversion of welding apparatus to a solar power supply has substantially simplified this apparatus and made it more efficient. Photoelectric converters generate direct current. It is needed for the chemical reaction of breaking down water into oxygen and hydrogen, which takes place in the device. The current rectifier, which consumes a considerable amount of energy, is no longer needed.

Two modifications of the welding apparatus have been developed. They have a wide range of applications: from the installation of large metal structures to work on dental plates in mobile polyclinics.

FTD/SNAP
CSO: 1842/132

UDC 621.79.03

NEW WELDING EQUIPMENT FOR MECHANIZED WELDING AND TRENDS IN FURTHER DEVELOPMENT

Kiev AVTOMATICHESKAYA SVARKA in Russian No 5, May 84
(manuscript received 27 Dec 83) pp 50-56

CHVERTKO, A. I., doctor of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences

[Abstract] New equipment for mechanized electric-arc welding includes series PDG semiautomatic welding machines with controls developed jointly by the All-Union Scientific Research Institute of Electric Welding Equipment and the Kakhov manufacturing plant, updated versions of A547U and A825M semiautomatic welding machines, seven modifications in series A200 welding machines for automatic assembly lines, some of them replacing the present series A1400 machines, and series AD small welding trucks with necessary attachments transportable manually by one operator. The main trends toward achieving higher productivity and better product quality are introduction of "small-scale" mechanization, standardization of labor saving equipment for semiautomatic and automatic welding stations, and eventual robotization. In the case of arc welding, just as in the case of contact welding, the most critical operations are charging and discharging the machine, setting and guiding the electrode, and feeding the electrode, all of which is now increasingly done by program control. A special machine UD266 is available for welding parts in the shape of solids of revolution. The complexity of welding equipment is increased by combining two or four arcs in one machine, for welding "in row" or "in tandem" of different part pairs of different sizes. Such multielectrode welding machines are treated as assembly lines or particular links in larger assembly lines. Typical examples of high-quality equipment now produced by arc welding with new welding machines are cooling coils for power transformers and tanks of irregular shapes. Figures 11; references: 5 Russian.
[126-2415]

'ELU-9B' ELECTRON-BEAM WELDING UNIT

Moscow LENINSKOYE ZNAMYA in Russian 22 Aug 84, p 3

[Text] The "ELU-9B" electron-beam welding unit is intended for joining high-strength steels and chemically active alloys of great thickness; it has been modernized with the "BEP 60/15 k" power unit. This permits a sixfold increase in the electric power capacity and makes it possible to weld ring and longitudinal joints with a thickness of the metal being welded of up to 60 millimeters. The welding rate is as much as 20 meters per hour.

FTD/SNAP
CSO: 1842/132

LASER AND DIFFUSION WELDING EQUIPMENT R&D

Leningrad VECHERNIY LENINGRAD in Russian 14 Apr 84, p 2

KOLESNIKOVA, G.

[Abstract] The article reports on activities and developments of the department of specialized welding methods of the All-Union Scientific Research Institute of Electric Welding Equipment (VNIIESO).

Sergey Konstantinovich Kartavyy has been the head of this department for 15 years. He has received about 30 certificates of invention for his developments. Colleagues of Kartavyy who are mentioned are V. G. Yes'kin,deputy head of the department; candidates of technical sciences L. A. Shterin, V. S. Smirnov and V. N. Kiselev, heads of laboratories; and Yakov Pevzner and Aleksandr Laptev, junior science associates.

Kartavyy related that the department's four laboratories are working on the improvement of existing welding equipment and developing production processes and new welding machinery. They have developed 250 items of diffusion-welding equipment alone. Original developments which are now in production include a series of machines for diffusion welding in a vacuum, for welding flexible copper buses, and for joining parts with large surfaces.

Work on laser welding apparatus began a few years ago in the department, with the collaboration of specialists from the All-Union Scientific Research Institute of Electrothermal Equipment in Moscow and from Kiyev, Novosibirsk, Khar'kov and a number of Leningrad Institutes. An industrial continuous laser unit with a power of 1.2 kilowatts was developed and shown at the international exhibition "Elektro-82". This unit is intended for welding steel 1-2 millimeters thick and for heat treatment. Seven have been manufactured, and they are in operation at such places as Lyublino Casting Machinery Plant, the "Start" production association in Novgorod, the State Optics Institute imeni Vavilov, and the electrothermal-equipment institute. New and more powerful laser units with programmed control reportedly have been developed in Kartavyy's department. These units are said to be capable of welding, cutting and heat-treating practically any metal and its alloys, and of producing almost invisible welds.

A photograph is given showing Ye. G. Livshits, senior science associate, A. I. Gornostaypol'skiy, an engineer, and a worker testing equipment in the department's electron-beam welding laboratory.

FTD/SNAP
CSO: 1842/132

UDC 621.791.052.08:620.179.16:669.715

STUDY OF DEFORMATION AND FRACTURE OF AMg6N WELDABLE ALUMINUM ALLOY BY METHOD OF ACOUSTIC EMISSION

Kiev AVTOMATICHESKAYA SVARKA in Russian No 5, May 84
(manuscript received 3 Jan 83) pp 9-12

TIKHIY, candidate of technical sciences, BORSHCHEVSKAYA, D. G., candidate of physico-mathematical sciences, BIGUS, G. A., engineer, EVINA, T. Ya., engineer, and BOGOMAZ, T. N., engineer, Dnepropetrovsk

[Abstract] Acoustic emission during deformation of the AMg6N weldable aluminum alloy was studied as a means of detecting flaws and fractures as well as from the practical standpoint of nondestructive testing. For evaluation purposes, the acoustic emission data were compared with results of metallographic examination under an MIM-8M optical microscope, examination under a UEM-100 electron microscope, x-ray structural examination with a DRON-2.0 diffractometer, and micromechanical examination with a PMT-3 microhardness tester. Flat specimens 140 x 20 x 5 mm in size had each an artifically produced stress concentrator as indicator of the fracture site. They were polished with an 80% C_2H_5OH + 20% $HClO_3$ electrolyte. Examination of the fine structure was facilitated by chemical treatment of the surface with a 47% HNO_3 + 50% HCl + 3% HF etchant for 3-5 s. An analysis of most highly stressed sections and averages of five microhardness readings revealed the evolution of the dislocation pattern and the buildup of defects. While the specimens were loaded in a URM-10 (10 tons) universal tensile testing machine at strain rates of $0.5 \cdot 10^{-4}$-$0.5 \cdot 10^{-2}$ s^{-1}, acoustic emission signals were recorded by an IAS-3 instrument. Intensity and amplitude of acoustic signals served as criteria of deformation activity and energy in sites emitting mechanical stress waves. The study has established the existence of a correlation between acoustic activity in this aluminum alloy and changes in its morphological as well as structure-sensitive characteristics during various stages of elastic-plastic deformation with attendant micro- and macrofractures. Figures 5; references 5: all Russian. [126-2415]

ELECTRIC WELDING INSTITUTE'S SPACE-TECHNOLOGY TEST RESULTS

Baku VYSHKA in Russian 28 Jul 84, p 2

LATINA, T., correspondent

[Abstract] The article comments on some of the space-technology developments of the Ukrainian Academy of Sciences' Institute of Electric Welding, including the multipurpose hand tool (URI) which cosmonauts on board the orbiting station "Salyut-7" used recently in welding and spray-coating operations in outer space. Mention is made of some of the facilities which are used to test space technology at this institute. These facilities are said to include a large

pressure chamber, which is intended for the testing of structurals in conditions of a vacuum, and a testing-and-training-simulator unit. This unit is used to test the comfort of the upper parts of space suits during work with new welding tools in space conditions. Doctor of Technical Sciences V. Bernadskiy, scientific secretary of the institute, mentioned that its developments for space missions are largely adaptations of equipment which is intended for work on Earth. The URI, for example, is said to be a space variant of a small, series-produced apparatus for electron-beam welding.

FTD/SNAP
CSO: 1842/132

MISCELLANEOUS

NOISELESS ALLOYS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 22 Aug 84 p 2

[Article by A. Presnyakov, engineer, "Alloy Suppresses Noise," Moscow]

[Text] Two little bells of the same shape were suspended at rest.

"Well, let us start," suggested professor M. Drits and offered me a little ball on the end of a handle. I hit one of the little bells. It produced a melodious sound. Then I touched the second little bell. But is remained silent. Why?

"The first little bell is made of ordinary steel, while the other one is made of special vibration suppressing alloy," explained M. Drits.

Scientists of the Metallurgy Institute imeni A. A. Baykov of the USSR Academy of Sciences are actively working to produce vibration-suppressing alloys.

The alloys are necessary to reduce the noise of operating machines in production shops, on city streets and near airports. Even the noise of operating refrigerators, washing machines and electric shavers is annoying.

Investigators established the reason for the origin of the noise. It is generated by the vibration of metals that excite elastic waves in the material which are carriers of energy and are resonant oscillations. This so-called vibration activity is the property of structural materials themselves. Besides intensifying the noise, unhealthy to people, vibration activity reflects negatively on the machines. It shortens their lives. Scientists set themselves a goal: not only to discover the causes of vibration activity, but also to find methods to eliminate it.

Fundamental investigations and the following experiments established that in the process of generating vibration, reversible structural changes can occur in the material on which the energy of elastic oscillations can be spent. In this case, the oscillations are suppressed, the material stops vibrating and becomes as though "deaf." If such structural changes do not occur, oscillations are practically not suppressed and the material sings in various ways. The discovery of this physical picture served as a basis for developing special vibration suppressing alloys.

"Together with people in our laboratory," noted M. Drits, "scientific staff workers at the Moscow High Technical School imeni Bauman are actively participating in developing vibration suppressing alloys."

"We have already obtained noiseless alloys of light and heavy metals. We recommend their use for frames and housing units on air cushions on ships, textile machines, planes, ship propellers, turbine vanes..."

"The value of new design materials is not only that they reduce noise sharply. They also make it possible to increase the operating life of equipment."

"Are not components for vibration-suppressing alloys scarce or expensive metals?" I asked.

"Fortunately, no. We established that by using magnesium, manganese, iron, titanium and several other metals containing alloying additives, it is possible to obtain compositions that are able to suppress vibrations. Of special interest are alloys using manganese with the addition of several elements. Parts of any shape can be cast from them. They are machined easily and can be welded. Experimental lots of gears, springs, housing parts of electrical machines and drilling equipment have already been made."

"Which sectors have already started to introduce new vibration-suppressing alloys?" I asked.

"First, textile machinebuilding, polygraphy and shipbuilding. We think that the rates of introducing vibration-suppressing alloys will expand very widely. We should not forget that reducing noise is not only a very important technical problem, but also a social one. In fact, by suppressing noise, we will make life more comfortable."

2291
CSO: 1842/151

PLASMA BEAM METHOD FOR RECONDITIONING TURBINE BLADES

Moscow PRAVDA in Russian 22 Sep 84, p 3

[Article by O. Gusev]

[Excerpt] Two turbine blades were lying side by side. One differed from the other only by the presence of a barely perceptible weld.

"Only a year ago, not a single welder in the world could have made such a weld in a gas-turbine blade," explained V. Sklyarevich, senior science associate of the Ukrainian Academy of Sciences' Institute of Electric Welding imeni Paton. "The tools and technology did not exist."

A decision was made at the electric welding institute to replace conventional welding tools, which are usually employed in the repairing of turbines, with ones that are new in principle. The electric arc was replaced by plasma.

Directing the 'sting' with a jeweler's precision at just the part of a relatively thin blade that has been subjected to wear--this was the task faced by researchers of the department headed by Doctor of Technical Sciences V. Gvozdetskiy.

At first the new plasma pistol could not be taught to 'hit the bull's eye' every time. Specialists of the All-Union Trust for the Repair of Gas and Power Engineering Equipment and of the Ukrainian and Tyumen' gas industry associations helped the Kiyev scientists to aim precisely at the heart of the problem.

How to 'clad' the plasma beam, which literally incinerates all living and inanimate things, was what gave the researchers the most trouble. As often happens, the experimenters received help from specialists in industry. In the course of joint research, they got the idea of compressing the plasma generator's beam by means of an electric field instead of 'cladding' the beam in any kind of material sheath. This idea proved successful.

With the aid of the plasma beam, turbine blades can be reconditioned six to eight times before they completely exhaust their service life.

FTD/SNAP
CSO: 1842/132

WORK ON MATERIALS FOR FAR NORTH AT TOMSK INSTITUTE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 24 Jul 84, p 2

[Text] A new research center--the Institute of the Physics of Strength and Materials Science of the USSR Academy of Sciences' Siberian Branch--has been created in Tomsk. This institute's tasks include the formulation of physical principles of powder metallurgy and the application of powder coatings, as well as the development of new materials intended for service in the conditions of Siberia and the Far North.

(The photograph shows junior science associate T. Poletika and a researcher-trainee working with equipment in an electron microscopy laboratory.)

FTD/SNAP
CSO: 1842/132

UNIT FOR RECOVERING METALS FROM PROCESS WATER

Moscow PRAVDA in Russian 9 Sep 84 p 3

[Article by I. Lakhno, correspondent]

[Text] Khar'kov--A 'net' for catching metals dissolved in water has been made available to machine builders.

This 'seine' was 'tied' by Doctor of Chemical Sciences, Prof. N. Dykhanov and the group of specialists that he heads at the All-Union Scientific Research Institute for Water Protection, which is located in Khar'kov. The high effectiveness of the method of removing ions of chromium, nickel, copper, lead and other heavy metals from industrial process water has been proved at Khar'kov's "Metalloshtamp" plant. The new unit's operational simplicity and reliability not only allow repeated industrial use of water, but also its discharge into rivers without harm to living things.

FTD/SNAP
CSO: 1842/132

METALLURGY INSTITUTE'S DEVELOPMENTS FOR ALLOY AND AIRCRAFT PRODUCERS

Tbilisi ZARYA VOSTOKA in Russian 4 Sep 84, p 2

SIGUA, TENGIZ, deputy director, Georgian Academy of Sciences' Institute of Metallurgy

[Abstract] The lengthy article reports on improved metallurgical processes that the author's institute has developed for specific production facilities.

One development involved a process for obtaining a silicomanganese-titanium alloy which is used to deoxidize steel. This process was introduced at the Rustavi Metallurgical Plant. The author reports that present plans call for the plant to expand its assortment of steels deoxidized with the silicomanganese-titanium alloy, and to begin supplying the alloy to other steelmakers.

The author goes on to mention results of the metallurgy institute's cooperation with the Zestafoni Ferroalloys Plant, which is said to be the country's only producer of refined ferromanganese. A new process was developed for the purpose of expanding the plant's capacity for the production of this alloy without building a new shop, which would have consumed much time and investment capital. The new process, which was developed on a crash basis, increased the capacity of an electric furnace in an existing shop. It was recognized as an invention in 1983. The institute also took part in the development of a process for a new silicomanganese production facility that is under construction at the plant. The facility's first phase is scheduled for completion in 1986.

The author relates that the institute and the Aircraft Plant imeni Dimitrov have been doing important work on conserving scarce high-speed steels by recycling waste. In particular, the institute proposed a process for remelting waste products that involves alloying with nitrogen. This process makes it possible to heighten the durability of tools by approximately 15-20 percent, it is claimed. The process is scheduled for introduction at the plant this year and subsequently at other enterprises of the aircraft industry and at machine-building plants of the Georgian republic.

FTD/SNAP
CSO: 1842/132

HARD-ALLOY TOOLS PRODUCED BY ELECTROPHYSICAL AND PLASMA PROCESSES

Moscow IZVESTIYA in Russian 21 Aug 84, p 3

[Article by A. Boyarunas (Khar'kov)]

[Excerpt] The Khar'kov Tool Plant of the Ministry of the Machine-Tool Building and Tool Industry is cooperating successfully with many of our country's scientific research institutes.

Assorted tools equipped with a cutting ceramic and non-tungsten hard alloys have been introduced into large-series production in a brief period of time, for example. The Khar'kov Polytechnical Institute helped the plant to organize abrasive machining of non-tungsten hard alloys, using the latest electric physicochemical processes. In collaboration with the Khar'kov Physical-Technical Institute of the Ukrainian Academy of Sciences and the Ukrainian Institute for the Planning and Organization of Machine-Tool and Tool Industry, the plant was one of the first to put into operation, on an industrial scale, a fundamentally new process for strengthening metal-cutting tools by the method of plasma coating in a vacuum.

FTD/SNAP
CSO: 1842/132

UDC 66.046.4:546.623

REINFORCEMENT OF MOLYBDENUM DISILICIDE WITH NEMATIC CRYSTALS OF ALUMINUM OXIDE

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 20, No 7, Jul 84 (manuscript received 8 Dec 82) pp 1143-1147

ZAKHAROVA, G. I., ORDAN'YAN, S. S., PADERNO, V. N., SMOLINA, G. N. and VINOGRADOVA, Ye. S., Leningrad Institute of Technology imeni Lensovet

[Abstract] The purpose of reinforcing $MoSi_2$ with nematic Al_2O_3 crystals is to impart mechanical strength and thermal stability to the material with otherwise excellent characteristics, which include high heat resistance and high creep resistance as well as high electrical conductivity. In an experimental study of this problem Al_2O_3 whiskers with an approximately 1000:1 ratio of length to diameter and with 2.82 wt.% impurities (0.34% Al, 1.95% Si, 0.46% Fe, 0.59% C) were added to $MoSi_2$ containing 1.42 wt.% impurities (0.7% Si_{free}, 0.48% C_{bound}, 0.31% Fe). Interaction of both materials produces SiO, Al_2O, MoO_2, Mo, Al vapors and Mo_5Si_3 condensate at processing temperatures within the 2000-2500°K range (according to thermodynamic analysis) and Al^+, Al_2O^+, SiO^+, Si^+, AlO^+ ions at processing temperatures within the 1700-2100° K range (according to mass-spectrometry). At 1700°K the corresponding ion currents begin to build up slowly to steady-state levels, as a result of interaction in the solid phase. Reinforcing was done by four methods: slag casting, pressing with subsequent sintering, hot pressing, and extrusion. Measurements of the mechanical strength and its temperature dependence have revealed that extrusion yields the most satisfactory product. Addition of 17-19 wt.% starch glue as plasticizer does not excessively damage the reinforcing fibers and subsequent drying at room temperature in air with 70% relative humidity prevents warping and cracking, before the mixture is sintered at 1900°K in argon under a pressure of $5 \cdot 10^4$ Pa above atmospheric. A tensile strength of 490 MPa in bending at room temperature was attained with 10 vol.% Al_2O_3 fibers, 70% of them 3.0-6.0 mm long. The material ceased to be processable with more than 15 vol.% Al_2O_3 fibers. Figures 4; references 4: all Russian.
[153-2415]

TECHNOLOGY OF NEW MOLDAVIAN METALLURGICAL PLANT DESCRIBED

Kishinev SOVETSKAYA MOLDAVIYA in Russian 15 Jul 84, p 2

DEMICHEV, Ye., director of the Moldavian Metallurgical Plant (Rybnitsa)

[Abstract] The author discusses plans for the Moldavian Metallurgical Plant, whose construction began in Rybnitsa in 1981. The first phase of the plant is scheduled to go into operation on October 12 of this year, and the completion of the plant's construction is planned in 1985.

The author says the plant is one of several which are being built in the country for local recycling of ferrous metal scrap. It will produce rolled-metal products with small dimensions in a variety of shapes. The plant will employ 2,400 workers. Its annual capacity will be 700,000 tons of steel, of which 500,000 tons wll be merchant-mill products and 164,000 tons commercial blanks.

The plant's technology is said to be the latest in ferrous metallurgy. The steel-melting furnaces will be equipped, for the first time in the industry, with high-power transformers which allow melts to take place in 2 hours and 10 minutes. This is 90 minutes less than in furnaces now in operation. The final refining of the molten steel is to be accomplished outside the furnaces, by the method of blowing with inert gases. Soviet-made equipment will be employed in the plant's electric steel-melting shop, which equipment for the plant's rolling mill is being manufactured in East Germany. The production process will be controlled by computer complexes.

FTD/SNAP
CSO: 1842/132

SUPERPURE MATERIALS RESEARCH PLANNED

Moscow GUDOK in Russian 18 Aug 84, p 4

[Text] A huge spot of sunlight slid along the gentle hills and a winding road. Mirrors were adjusted, and this spot, squeezed into a ball, slipped through a thick sheet of aluminum. This was how the first heliostat of a unique research and production complex, "Solntse" (sun), performed during tests. This complex is under construction at an elevation of more than 1,000 meters above sea level in spurs of the Tyan'-Shan' Mountains, in Tashkent Oblast.

There will be 62 such heliostats here. Each will have an area of 50 square meters. They will transmit hot rays to a concentrator's curved mirror, which will be truly gigantic--2,000 square meters. And the beam 'springing' from this mirror will easily melt not only aluminum but also almost every material known on our planet. A special melting furnace at which the concentrator will direct hundreds of kilowatts of energy will burn brighter than a thousand suns.

The complex which is under construction is intended for obtaining materials which are super-refractory and at the same time superpure. Such materials are needed by many branches of industry. These materials are very difficult to obtain by conventional chemical methods and even by the most modern microwave and electron-beam ones. Basic research in the fields of the utilization of solar energy and high-temperature and semiconductor physics also will be conducted here. A large group of physicists headed by S. Azimov, member of the Uzbek Academy of Sciences, has been engaged in this research during recent decades.

FTD/SNAP
CSO: 1842/132

IMPROVED REINFORCEMENT METAL

Moscow STROITEL'NAYA GAZETA in Russian 26 Aug 84, p 3

[Article by Romaniv, O., Doctor of Technical Sciences, Professor, deputy director of UkSSR Physico-Mechanical Institute im. Karpenko

[Excerpt] The introduction of high-strength rolled metal as reinforcement metal for the production of prestressed reinforced concrete has become a promising direction of reducing the metal-intensiveness and cost of construction products and heightening their reliability and durability. The growing use of this valuable metal, however, has made it necessary to pay more attention to protecting it against corrosion.

We and the USSR State Construction Committee's Scientific Research Institute of Concrete and Reinforced Concrete (NIIZHB) have jointly carried out a complex of research and studied the effects of industrial heat treatment, the chemical composition of reinforcement and various concrete additives on metal. As a result, certain brands of steel have been recommended to enterprises of the construction industry for manufacturing prestressed reinforced concrete.

The development of a process for making high-strength reinforcement wire with low rheological and high corrosion-and-mechanical properties has been completed in collaboration with the USSR Ministry of Ferrous Metallurgy's All-Union Scientific Research Institute of the Metalware Industry and with NIIZHB. The introduction of this process at ferrous-metallurgy enterprises is planned next year.

Within the framework of a republic program called "Materialoyemkost'" (material-intensiveness), we, the Ukrainian Academy of Sciences' Institute of Physical Chemistry imeni Pisarzhevskiy and a number of enterprises of various ministries are developing a process for manufacturing a thickened polyethylene that is chemically and thermally stable by the method of electron irradiation, as well as products made of this material for the shaping of reinforced-concrete products.

Concrete forms made of metal, rubber, epoxy resins and gypsum cement which are now in use have a number of drawbacks. Irradiated polyethylene is an advantageous replacement for them.

Experimental-industrial tests of elements made of filled and irradiated polyethylene have been done at the Kalush Reinforced Concrete Products Plant. These tests have confirmed the expediency of employing this material; moreover, the process eliminates the need for cleaning and lubricating forms.

FTD/SNAP
CSO: 1842/132

UDC 620.191.7:549.31

EFFECT OF OXIDIZING MEDIUM AND HEAT TREATMENT ON STOICHIOMETRY OF ZnSe CRYSTAL SURFACE

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 6, Jun 84 (manuscript received 7 Feb 83, final edition received 28 Jul 83) pp 145-152

SOTNIKOV, V. T. and DOBROTVORSKIY, S. S., Kharkov Institute of Aviation

[Abstract] The chemical composition of ZnSe crystals at the surface after heat treatment under vacuum, without and with an oxidizing medium, was studied by both Auger-electron spectroscopy and secondary-ion mass-spectroscopy. Crystals of ZnSe were grown from a melt under pressure in an inert atmosphere. After mechanical grinding and polishing, they were cut into 8 x 4 x 2 mm bars for mass-spectroscopy with an LAS-600 "Riber" instrument and Auger spectroscopy with 0.4% resolution under a residual gas pressure of 10^{-7} Pa. The crystal surface was decontaminated by ion sputtering. Heat treatment involved annealing at 650-700°K, temperatures close to the 700-800°K range corresponding to appreciable changes in optical properties. Heating without oxidation resulted in a higher surface concentration of Se atoms, these excess Se atoms being accompanied by Na, K, Li, Cs impurity atoms. Surface oxidation was effected plainly with commercial oxygen at a pressure of $2 \cdot 10^{-4}$ Pa at room temperature, with traces of water vapor. Surface oxidation was also effected with stimulation and intensification by electron bombardment. The spectra of Auger electrons and the kinetics of these spectra under the various conditions of heat treatment reveal intense oxidation and hydrolysis of the Zn Se surface, accompanied by a decrease of the Se surface concentration and an increase of the Zn surface concentration along with formation of ZnOH and $Zn(OH)_2$ hydroxides indicated by the ion-mass spectra. The spectra also indicate a thermomechanical mechanism of oxidation during electron bombardment. Figures 6; references 14: 12 Russian, 2 Western (1 in Russian translation).
[129-2415]

'DUP-37' ULTRASONIC FLAW DETECTOR FOR METAL PRODUCTS

Moscow LENINSKOYE ZNAMYA in Russian 1 Aug 84, p 3

[Text] A checker no longer has to take apart and reassemble parts in order to detect various flaws (cavities, cracks, pores and nonmetallic inclusions) in blanks and products made of ferrous and nonferrous metals. A portable ultrasonic flaw detector, the "DUP-37", sends ultrasonic vibrational pulses to the part of a product that is being inspected and receives signals which have passed through the part or have been reflected from a flaw and the bottom of the product. This innovation operates by echo-pulse and shadow methods, in contact and immersion variants, and with straight, inclined and separately aligned finders.

FTD/SNAP
CSO: 1842/132

UDC 669.725

DEPENDENCE OF MICROPLASTICITY OF BERYLLIUM ON GRAIN SIZE AND HEAT TREATMENT

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 57, No 6, Jun 84 (manuscript received 25 Apr 83, after final editing 20 Jun 83) pp 1211-1213

PAPIROV, I. I., KARPOV, Ye. S., TIKHINSKIY, G. F., VERTKOV, A. V. and IVANTSOV, I. G., Kharkov Physico-Technical Institute, UkSSR Academy of Sciences

[Abstract] In earlier study of high-purity polycrystalline beryllium in the microplastic state corresponding to the $\varepsilon = 10^{-7}$-10^{-4} range of strain revealed two or three stages of yield with different values of the hardening exponent and with smooth transitions between them. A subsequent study dealt with the dependence of this behavior on the grain size and the heat treatment. Experiments were performed with specimens of cast high-purity polycrystalline beryllium having a residual electrical resistivity corresponding to the ratio $R_{300K}/R_{77K} = 30$. The stress-strain curves were plotted on the basis of high-precision measurements with strain gauges under conditions of continuous loading or during loading-unloading cycles with shrinking of the hysteresis loop. The results indicate that beryllium obeys the Hall-Petsch relation $\sigma = \sigma_0 + Kd^{-1/2}$ between stress σ and grain diameter d within the d = 10-77 μm range at all strain levels including $\varepsilon = 2 \cdot 10^{-7}$ at the microyield point. It departs from this relation as d approaches 143 μm, insignificantly at high strain levels and increasingly so with decreasing strain level to a maximum deviation at $\varepsilon = 2 \cdot 10^{-7}$. The coefficient K increases with increasing strain and σ_0 becomes negative as d is extrapolated to ∞. These anomalies are attributed to dissolution of impurities existing even in high-purity beryllium, as a result of aging and simultaneously with the growth of beryllium grains. The yield point is more sensitive to change in grain size than to change in composition and, at high annealing temperatures, depends also on parameters of the recrystallization process. Figures 3; references 3: all Russian.
[154-2415]

ALUMINUM-BASED COMPOSITE MATERIALS FOR STRENGTHENING MACHINE PARTS

Minsk SOVETSKAYA BELORUSSIYA in Russian 18 Aug 84, p 2

[Text] Composite materials based on aluminum have been developed at the Belorussian Academy of Sciences' Physical-Technical Institute. These materials open up great possibilities for reducing the weight of machines and equipment through the utilization of lightweight shapes with high strength. The new materials are also suitable for hardening parts by the method of hard-facing or spray-coating their working surfaces.

At the Kiev Tractor Parts Plant and the turbomotor plant in Sverdlovsk, the economic effect from use of the composite materials in the production of pistons for diesel engines has been more than 100,000 rubles a year.

FTD/SNAP
CSO: 1842/132

UDC 620.193.82:629.12

STUDY OF CORROSION AND CORROSION-FATIGUE PROPERTIES OF 10KhSND STEEL IN NATURAL SEA WATER AND A MEDIUM SATURATED WITH MARINE BACTERIA

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 2, Mar-Apr 84 (manuscript received 10 Nov 82) pp 36-38

TSOKUR, N. I. and KOBZARUK, A. V., Institute of Physics and Mechanics, imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] Corrosion and corrosion-fatigue testing of specimens was performed in natural sea water, sterile bacteria-free sea water, sterile sea water with a 2-day associative culture of three species of aerobic saprophytic bacteria grown on a solid nutrient medium, and sterile sea water with bacteria plus 10 ml/l meat-peptone boullion in order to determine the influence of aerobic saprophytes of the genera bacterium and pseudomonas on the corrosion fatigue of this steel, commonly used in shipbuilding. The studies show that the kinetics of corrosion and low-cycle durability are related to the rate of development of microorganisms. Figures 2; references 8: all Russian. [108-6508]

'SNV-1,3,1/16 MOG' CARBONITRIDING FURNACE

Moscow LENINSKOYE ZNAMYA in Russian 22 Aug 84 p 3

[Text] The carbonitriding process doubles or triples the wear resistance of cutters, reamers and drills. This is a chemical heat treatment of tools in a vacuum with the utilization of ammonia, acetylene and argon.

The increased wear resistance of the tools is achieved by saturating their surface layer with the decomposition products of ammonia at a temperature of 540-550 degrees and a pressure of about 0.3 atmosphere. The carbonitriding is performed in the "SNV-1,3,1/16 MOG" furnace, which is equipped with a gas intake.

FTD/SNAP
CSO: 1842/132

UDC 537.311.33

PRODUCING SEMICONDUCTOR MATERIALS BY SUPERFAST COOLING OF MELT

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 20, No 7, Jul 84 pp 1238-1243

GLAZOV, V. M., Moscow Institute of Electronic Engineering

[Abstract] Superfast cooling of semiconductor melts makes it possible to achieve deep subcooling, which can result in either glass transition or diffusionless crystallization. Both effects, just as amorphization, can yield materials with anomalous structure and special properties. Here both effects are analyzed from the standpoint of thermodynamics and demonstrated on Ge-$A^{III}B^{V}$ quasi-binary systems ($A^{III}B^{V}$ = GaSb, GaAs, GaP, InP). In an experimental study melts were cooled at rates of 10^{7}-10^{8} K/s in a special apparatus. Surface crystallization of specimens was effected in a copper cup rotating at 8000 rpm and vibrating at 130 Hz in an atmosphere of pure argon. An x-ray diffraction analysis has revealed deviations from Vegard's law, positive in Ge-GaSb, Ge-GaAs negative in Ge-GaP, Ge-InP. The dependence of the lattice parameter on the state of metastable solid solutions is most probably attributable to a strong dissociation of the $A^{III}B^{V}$ compound within corresponding ranges of its concentration, with subsequent formation of mixed substitutional and interstitial solid solutions. A related item of interest is formation of supersaturated metastable solid solutions in binary systems with intricate interaction, namely in $A_2^{V}B_3^{VI}$ systems (Bi-Te, Sb-Te, Bi-Se). The feasibility of crystallization into a homogeneous solid solution in this case is demonstrated by Be_2Te_3-Bi_2Se_3 and $Bi_2Te_3Sb_2Te_3$ quasi-binary systems. Micrononhomogeneity resulting from segregation of the more refractory component within the temperature range between liquidus and solidus lines can be overcome most likely by superfast cooling without the need for diffusion. This prediction is based on kinetic and thermodynamic characteristics, phase diagrams, and x-ray spectral microanalysis of $Bi_2Te_{3-x}Se_x$ (x = 0.3-2.1) and $Sb_{2-x}Bi_xTe_3$ (x = 0.2-1.8) alloys, the latter produced by the technique of powder metallurgy. Figures 6; references 18: 17 Russian, 1 Western.
[153-2415]

UDC 669.15'24'28:548.76/73.295

SHAPE MEMORY AND STRUCTURAL PERSISTENCE IN 40KhN3M STEEL

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 1, Jul 84 (manuscript received 22 Jul 83) pp 106-112

ZAYMOVSKIY, V. A. and FALDIN, S. A., Moscow Institute of Steel and Alloys

[Abstract] Strips of 40KhN3M structural steel (0.41% C, 1.21% Cr, 3.25% Ni, 0.64% Mo, 0.73% Mn, 0.32% Si) smelted in an induction furnace, 105 mm long and 18 x 45 mm in cross section, were subjected to a sequence of heat treatment under a tensile load: austenization at 900°C for 30 min - cooling to 600°C - soaking at 600°C for 10 h - cooling in furnace - austenization at 900°C and 1200°C for 3-5 h - soaking in bath at the bainite transformation temperature of 280°C. They were then mounted in a tensile testing machine, where neither a magnetometer and a ballistic galvanometer nor X-radiography revealed any residual austenite in the end product. During soaking the load was held at levels up to 200 MPa, in a special experiment the load was varied over the 200-500 MPa range, and on the stress-strain curve recorded after subcooling down to the austenite isotherm the yield point was found to be $\sigma_{0.2}$ = 220 MPa. The mechanical characteristics of the bainite were measured by heating in a DL-1500 Ulvac Sinko-Rico dilatometer at rates of 1-300°C/min, its microstructure was examined under pressure and without. An analysis on the basis of the Patel-Cohen model and the $\alpha \rightarrow \gamma$ transformation dilatogram as well as strain kinetics during bainite transformation under pressure and strain kinetics during second heating reveals that that external pressure tends to crystallographically sort out the orientations of bainite crystals and thus build up strains. These strains vanish almost completely and the original austenitic orientations are restored upon heating under conditions favorable to structural persistence. This effect, a manifestation of shape memory, produces a strong corresponding dilatometric anomaly. Figures 6; references 12: 7 Russian, 5 Western (1 in Russian translation).
[155-2415]

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31 Oct 1984